Chemicals Recovery from Food Waste

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Introduction

Food waste (FW) treatment EXISTING ROUTE: Anaerobic digestion

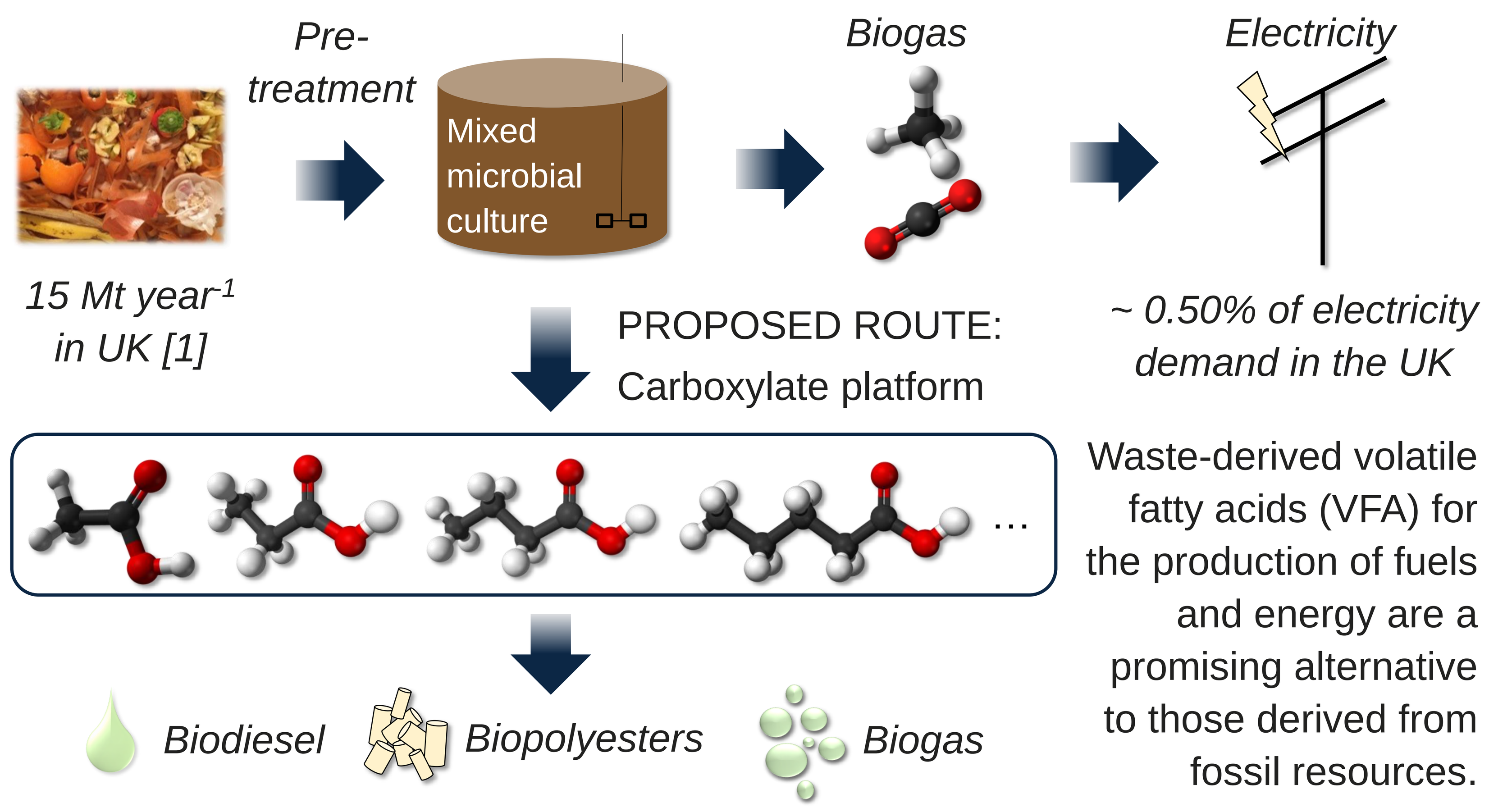
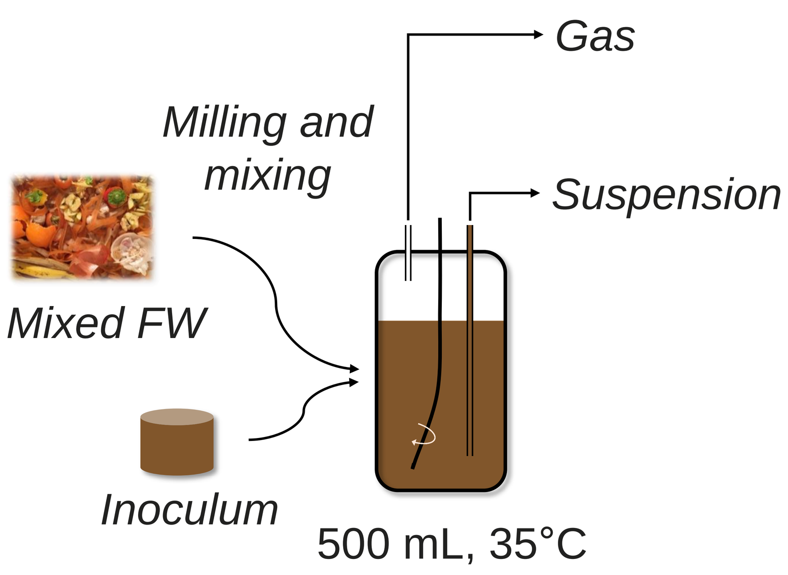


Figure 1. *Proposed scheme for recovery of chemicals from FW.*

Objective

In this study we evaluated the operational conditions required for both VFA and biogas optimal production to maximize the VFA recovery from FW.

Methodology



1. Biochemical methane potential tests:
   - 30 days, 5 g COD L^{-1} substrate, 10 g VS L^{-1} inoculum
   - Evaluation of methane production, solids and organics degradation
2. Batch fermentation tests:
   - 7 days, varied substrate and inoculum concentration
   - Evaluation of sugars degradation to VFA and alcohols, biogas production, solids and organics degradation

Figure 2. *Experimental set-up.*

* COD: Chemical oxygen demand, VS: Volatile solids

1. Biochemical methane potential of mixed FW

Biochemical methane potential tests were performed to obtain digestibility and fermentation capacity of mixed FW.

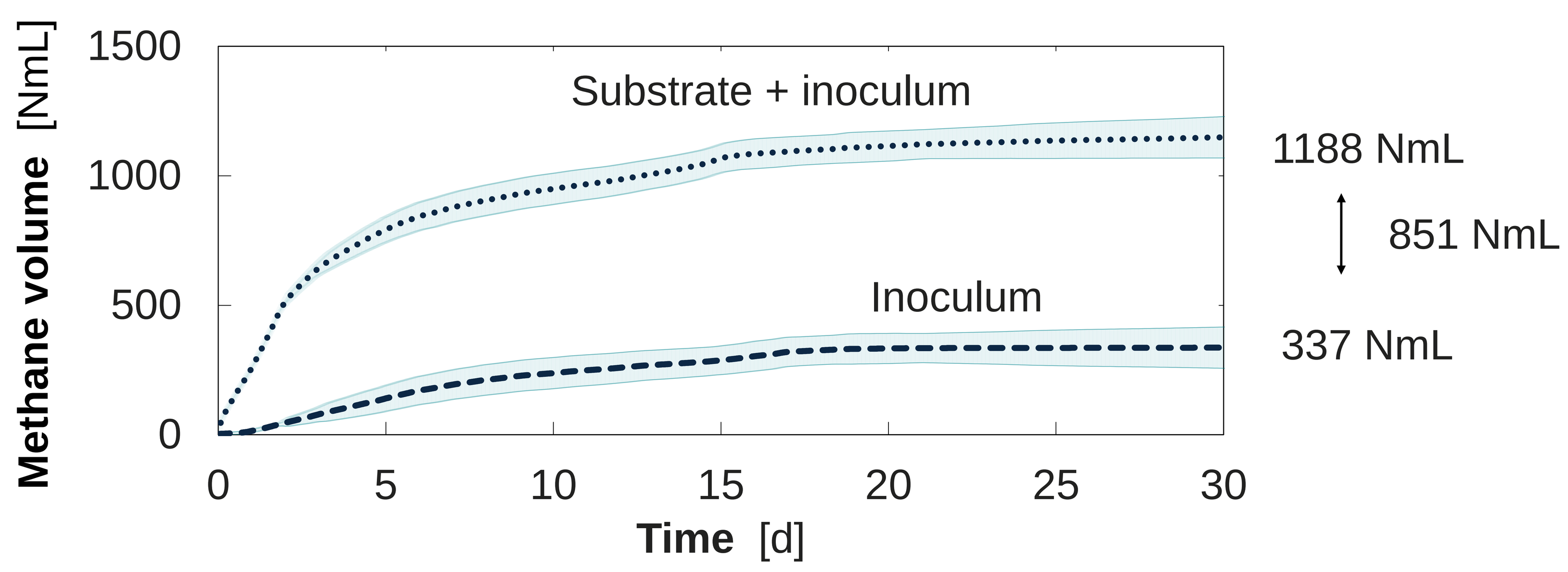


Figure 3. *Methane production from mixed FW.*

- Biodegradadability = COD of methane produced/COD of substrate fed ≈ 100 %
- Preliminary findings indicate that the COD of the mixed FW was nearly completely converted into methane.

2. Batch fermentation tests of mixed FW

Batch fermentation tests were performed at different food-to-microorganism (F/M) ratios and organic loads to determine limiting conditions for VFA production and identify production of intermediates and biogas.

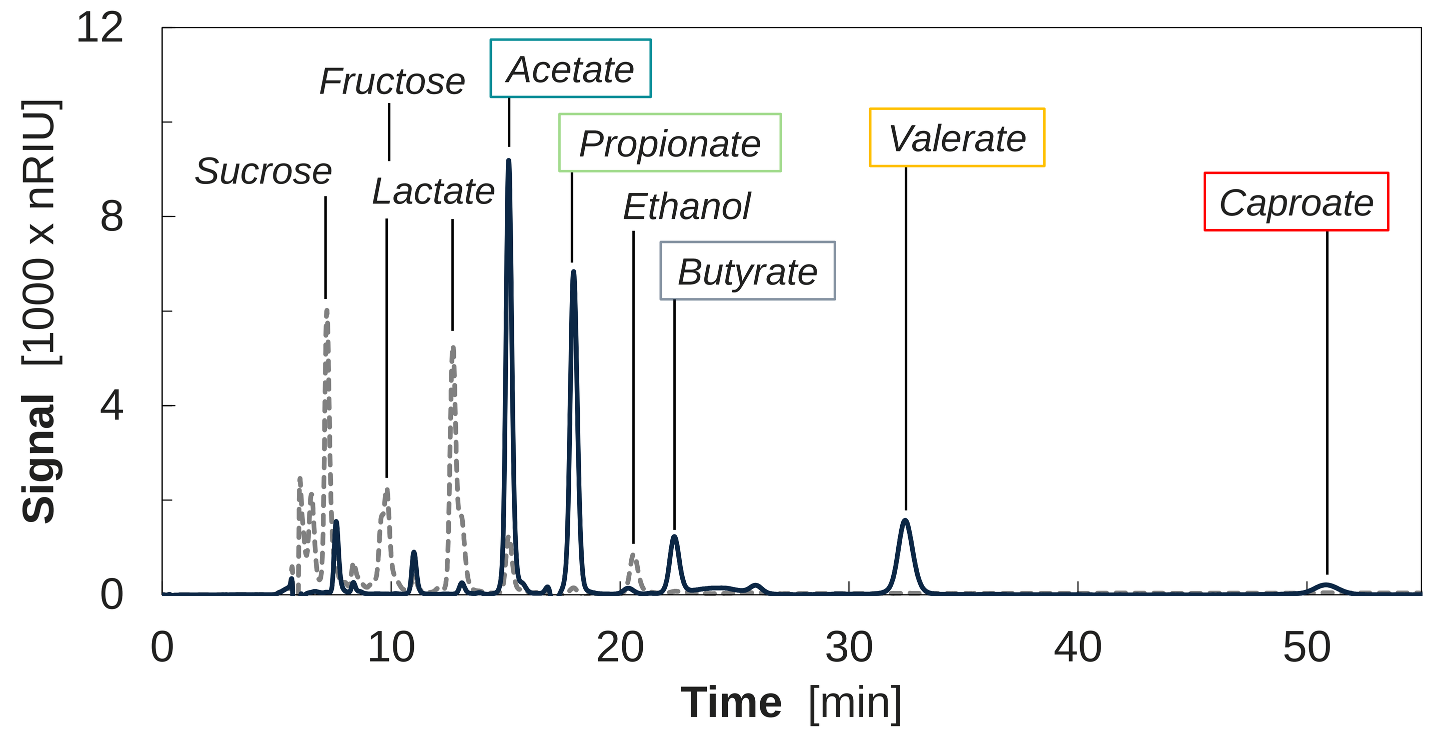


Figure 4. *Optimised methodology for simultaneous sugars and VFA analysis by HPLC. Chromatograms show initial (dotted line) and final (solid line) composition at a F/M ratio of 5 g COD/1 g VS.*

$$\text{Degree of acidification (DA)} = \frac{\text{COD of VFA produced}}{\text{COD of substrate fed}}$$

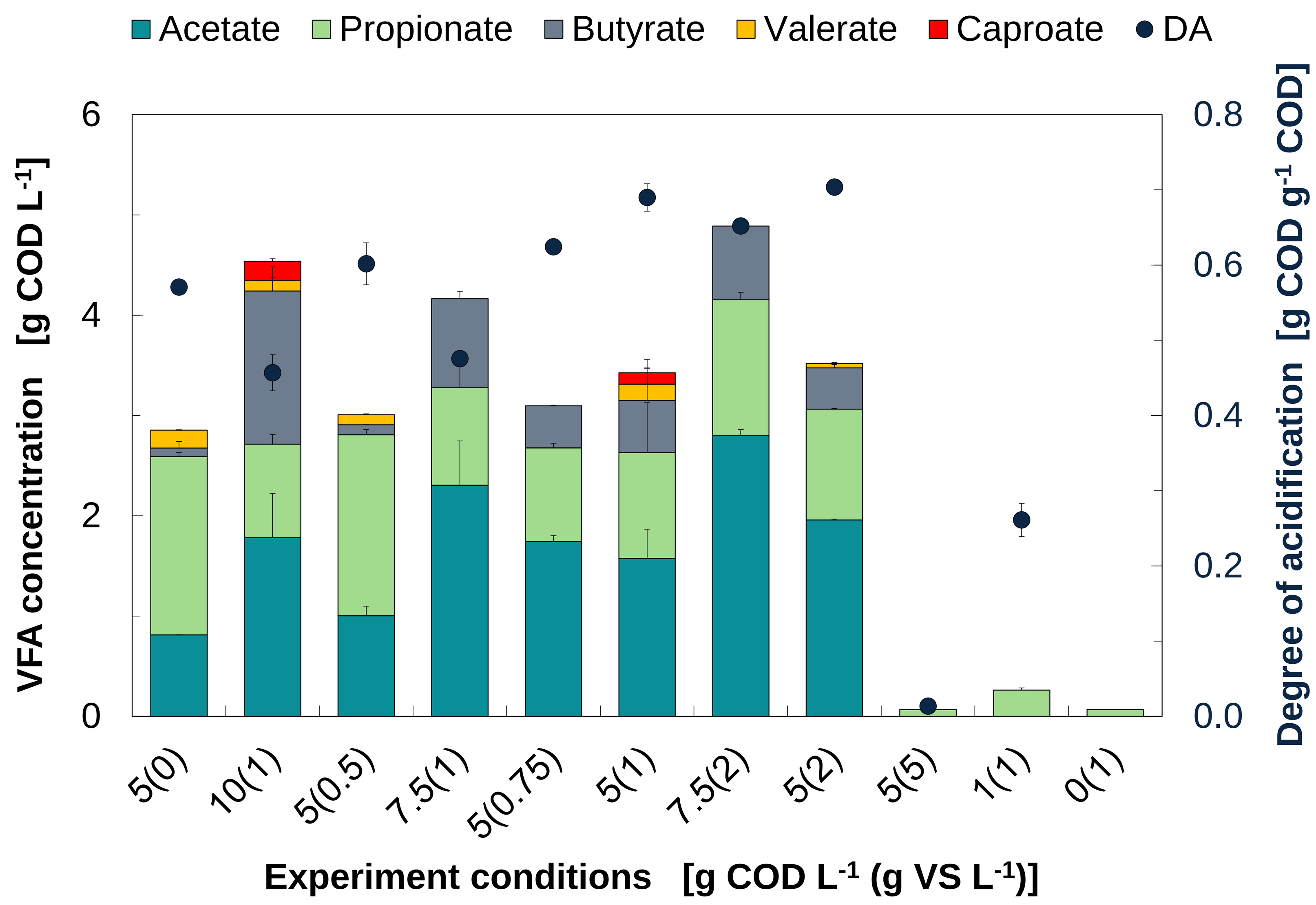


Figure 5. *VFA production and DA for different F/M ratios and organic loads.*

- The highest VFA concentration of 4.9 g COD L^{-1} was obtained at a F/M ratio of 3.75. Main compounds were acetate and propionate.
- A DA of 0.7 g COD g^{-1} COD was achieved with a substrate concentration of 5 g COD L^{-1}, which indicates the high acidogenic potential of the mixed FW [2].
- Traces of valerate and caproate were identified under certain conditions.
- Continuous biogas production was only observed at 5 g COD L^{-1} substrate and 5 g VS L^{-1} inoculum (F/M ratio of 1).

Conclusion

Food-to-microorganism ratios have been identified to maximise performance with respect to VFA production and degree of acidification. Further sources of FW are characterised utilising these finding to determine the stability of the VFA or biogas production and predict valuable resources such as proteins or inorganics to contribute to sustainable development of energy resources.

References

[1] Waste & Resources Action Programme, 2015. *Estimates of Food and Packaging Waste in the UK Grocery Retail and Hospitality Supply Chains*. Tech. rept.

[2] Silva *et al*., 2013. *Chem. Biochem. Eng. Q.*, 27 (4), 467–476.

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